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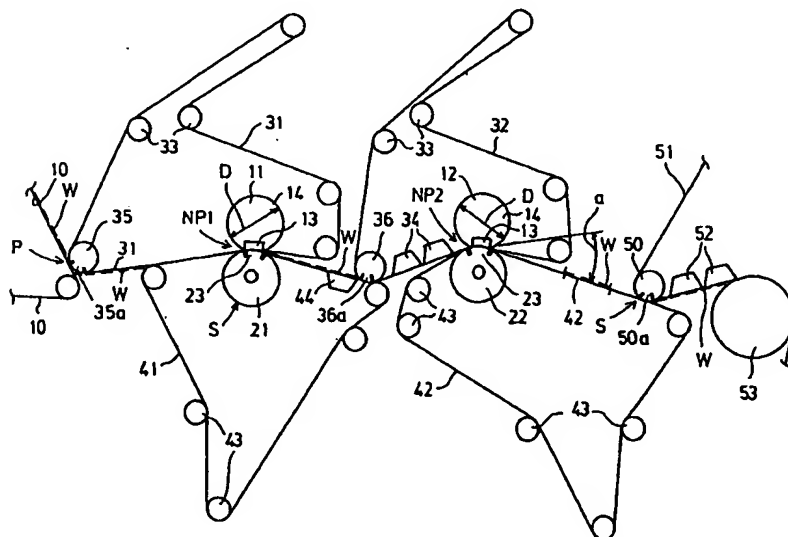
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(54) Title: PRESS SECTION IN A PAPER MACHINE, IN WHICH PRESS SECTION ONE OR SEVERAL EXTENDED NIPS IS/ARE APPLIED

(57) Abstract

A press section in a paper machine, which press section comprises at least two separate press nips (NP1, NP2; N1, N2, N10, N20, N30, NP10, NP11, NP20, NP21, NP30). The paper web (W) is passed through these nips as a closed draw. In the press section there is at least one press nip provided with two press felts (31, 41; 32, 42) that receive water, through which press nip the paper web (W) runs between said press felts (31, 41; 32, 42). After the last-mentioned nip the paper web (W) is separated from one of the press felts (31/41; 32/42) and transferred on support of the other press felt (41/31; 42/32) as a closed draw further. The last nip is an extended-nip zone (NP2; NP10; NP20, NP21, NP30), in

which one roll is a shoe roll (12) provided with a hose mantle (14) and with a press shoe arrangement (13), and the other roll is a press suction roll (22) provided with a suction zone (23). The paper web (W) is passed through the last extended-nip zone (NP2; NP10; NP20, NP21, NP30) between two press fabrics (32, 42). Directly after the last extended-nip zone (NP2; NP10; NP20, NP21, NP30) the paper web (W) is separated from one of the press fabrics (32/42) and transferred, with the aid of the vacuum present in the suction zone (23) of the press suction roll (22), to follow the press fabric (42/32) placed at the side of the press suction roll (22) without rewetting. The web (W) is passed on the latter press fabric (32; 42) as a closed draw onto a drying wire (51) of the dryer section. Further, a modification of the press section is described in which an extended-nip zone which corresponds to the extended-nip zone mentioned above and placed as the last nip is placed as the first nip in the press section.



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Press section in a paper machine, in which press section
one or several extended nips is/are applied

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The invention concerns a press section in a paper machine, which press section comprises at least two separate press nips, through which the paper web to be pressed is passed as a substantially closed draw and in which press section there is
10 at least one press nip provided with two press felts that receive water, through which press nip the paper web runs between said press felts and after which last-mentioned nip the paper web is separated from one of the press felts and transferred on support of the other press felt substantially as a closed draw further.

15 One of the most important quality requirements of all paper and board grades is uniformity of the structure both on the micro scale and on the macro scale. The structure of paper, in particular of printing paper, must also be symmetric. Good printing properties required from printing paper mean good smoothness, evenness and certain absorption properties of both faces. The properties of paper, in particular
20 the symmetry of density, are affected considerably by the operation of the press section of a paper machine, which operation also has a decisive significance for the evenness of the profiles of the paper in the cross direction and in the machine direction.

25 Increased running speeds of paper machines also provide new problems to be solved, which are mostly related to the runnability of the machine. At present, machine speeds as high as even above 1600 m/min (metres per minute) are used. At these speeds, so-called closed press sections, which comprise a compact combination of press rolls fitted around a smooth-faced centre roll, usually operate satisfactorily. As
30 examples of such press sections should be mentioned the applicant's SymPress II™ and SymPress O™ press sections.

In recent years, so-called shoe presses have become more common rapidly, in which presses one of the press rolls is a shoe roll provided with a flexible hose mantle, and the backup roll is a press roll, as a rule a solid-mantle hollow-faced adjustable-crown or variable-crown roll, such as the applicant's **SymZL™ Roll**. Said extended-nip
5 press is marketed by the applicant with the trade mark **SymBelt™ Press**. Thus, it is an object of the present invention to develop new concepts in which an extended-nip press or presses is/are utilized in a novel, advantageous way.

From the point of view of energy economy, dewatering taking place by pressing is
10 preferable to dewatering taking place by evaporation. This is why attempts should be made to remove a maximal proportion of water out of a paper web by pressing in order that the proportion of water to be removed by evaporation could be made as little as possible. An increase in the running speeds of paper machines even up to the range of ~ 2000 m/min, however, provides new problems in particular for
15 dewatering taking place by pressing, because the press impulse and the peak pressure in roll presses cannot be raised beyond a certain limit without destruction of the structure of the web and because at high speeds the nip times remain inadequately short.

20 Solutions for the problems mentioned above are partly provided by said extended-nip presses, such as the applicant's said **SymBelt™ Press**.

With increased running speeds of paper machines, the problems of runnability of the paper machines are also manifested with increased emphasis, because the web with
25 a high content of water and low strength does not tolerate the dynamic forces arising from high speeds and from changes in direction, but web breaks and other disturbance in operation arise, which result in standstills. This is why the press sections in paper machines are about to become a bottleneck when attempts are made to increase the running speeds of paper machines to the range of 2000 m/min.

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A particular problem in the prior-art press sections is so-called rewetting, which means that the water that has been forced into the press felt in the nip zone moves

back into the web. This is a particularly severe problem after the last nip, in which nip the ultimate dry solids content of the web is determined, the rewetting tending to lower said dry solids content. In a number of prior-art press sections, it has been a substantial drawback that the dry solids content of the paper web has become lower
5 by several percentage units, in comparison with what had been obtained as the dry solids content directly after the last press nip, before the web has been passed to the dryer section.

In prior-art presses, it has often also been a problem, after the nip zone, how to
10 make the web follow exactly a specified press fabric or transfer band whose function is to carry the web further, which must take place under all varying running conditions and irrespective of the type, condition or age of the press fabric or transfer band that is used. In practice, it is already determined in the nip zone which fabric or band the web will follow after the nip zone. As is known from the prior
15 art, attempts have been made to ensure that the web follows exactly the specified press felt by using different felt angles, suction zones and/or transfer suction rolls, whose suction zone extends to outside the press nip zone proper.

In the following, the operation of prior-art, primarily closed roll presses and the
20 requirements of development noticed in them will be described.

The first nip in a press of the SymPress II™ type is a two-felt nip, and therein the upper roll is a suction roll, by the effect of whose vacuum the web follows the upper felt, which is, at the same time, the pick-up felt. This solution operates well in a
25 SymPress II™ press. In such a solution, the holding zone subjected to a vacuum starts from the first nip and continues up to the following nip, and the level of the vacuum has been arranged to be adjustable. Further, the coverage of the lower felt on the upper felt after the first nip has been regulated such that the runnability is good and that rewetting is minimized. It is a drawback that the pick-up felt runs
30 through two nips, so that wear and contamination of the felt occur. A roll nip in which one of the rolls is a suction roll limits the linear load to a maximal level of 100...150 kN/m. With shoe press solutions, the linear load can be raised up to

300...400 kN/m (max. 1500...2000 kN/m, depending on the backup roll), and the length of the nip can be varied, so that the dry solids content of the web that is achieved is higher and better controllable than with a roll nip.

5 With respect to the prior art most closely related to the present invention, reference is made to the applicant's *FI Patent Application 951934 (equivalent to US Patent No. 5,650,049 and to EP 0,740,017 A1)*, to the *US Patents Nos. 4,483,745 and 4,704,192 of Beloit Corporation*, and to the *Utility Model DE 297 01 948 U1 of Voith Sulzer Papiermaschinen GmbH*. Further, various geometries of extended-nip
10 presses have been described, among other things, in the applicant's *US Patent No. 4,976,820 and in the published EP Patent Application 0,487,483 A1 (equivalent to FI Pat. Appl. No. 905798)*. Further, reference is made to the published *Patent Applications WO 91/08339, WO 95/16821 of Beloit Corporation*, and to the *US Patent No. 5,178,732 (equivalent to DE 40 26 021) of J.M. Voith GmbH*, as well as
15 to *DE U1 92 06 340 and DE A1 41 12 355 of Sulzer-Escher Wyss GmbH*. These cited papers do, however, not disclose (a combination of) the characteristic features of the invention, which are indispensable in the present invention in order that the effects supposed to be achieved by means of the invention could be achieved.

20 The object of the present invention is to provide novel press section concepts in which it is largely possible to avoid the drawbacks discussed above and to provide a press section that, for its part, permits, if necessary, an increase of the running speed of a paper machine to the range of ~ 2000 m/min.

25 It is a particular object of the invention to provide a press section that is suitable in particular for the manufacture of printing and writing paper grades, whose basis weight is, as a rule < 100 g/m² (grams per square metre) and from which good symmetry in the z-direction and adequate smoothness and filler content of both surfaces are required.

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In view of achieving the objectives stated above and those that will come out later, a primary embodiment of the invention is mainly characterized in that the last nip in

the press section is an extended-nip zone, in which one roll is a shoe roll provided with a hose mantle and with a press shoe arrangement and the other roll is a press suction roll provided with a suction zone, that the paper web is passed through said last extended-nip zone between two press fabrics, that directly after said last
5 extended-nip zone the paper web is separated from one of the press fabrics and transferred, with the aid of the vacuum present in the suction zone of said press suction roll, to follow the press fabric placed at the side of said press suction roll without substantial rewetting, and that the paper web is passed on the latter press fabric as a closed draw onto a drying wire or equivalent of the dryer section follow-
10 ing after the press section, onto which drying wire or equivalent the web is transferred as a suction roll transfer or by means of an equivalent arrangement.

On the other hand, a secondary embodiment of the invention is mainly characterized in that two fabrics or equivalent are passed through the first extended-nip zone in the
15 press section, of which fabrics or equivalent at least one is a press felt that receives water, that said extended-nip zone is formed by a shoe roll provided with a flexible hose mantle and by a press suction roll operating opposite to said shoe roll and provided with a suction zone which is fitted in the area of said extended-nip zone, that said press felt that receives water has been fitted around, and in connection
20 with, said press suction roll so that the paper web is separated from the other press fabric and follows said press felt that receives water with the aid of the vacuum in the suction zone in the press suction roll without substantial rewetting, and that on said press felt the web is passed further as a closed draw onto a press fabric of the following press nip in the press section.

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The first and second embodiment of the invention mentioned above can be used synergically together as a combination. The embodiment of the invention that is currently considered to be preferable is its first embodiment.

30 In a two-felt nip or nips preferably applied in the present invention, water is removed out of the web into both felts, and by the effect of the vacuum in the press suction roll, after the nip, the web follows the correct felt to which the effect of the

vacuum is applied. In such a case, right after the nip, the press felts can be separated from one another immediately, and the web is transferred further on the face of the correct felt. Further, by the effect of the vacuum in the suction roll, the dewatering in the nip is enhanced, i.e. the dry solids content of the web is increased.

5 As the web follows exactly the correct felt right after the nip, the rewetting arising from the other felt after the nip is reduced, because the web is no longer in contact with said felt. Also, the rewetting arising from the felt that the web follows is reduced, because the vacuum in the suction roll keeps the water better in the felt, and the web absorbs less water as it expands (in the z-direction). Since, in the press
10 section in accordance with the invention, the web already chooses the correct felt in the nip, after the nip no separate transfer suction roll or equivalent is needed, by whose means the web could be forced to follow the correct felt. By means of such a transfer suction roll, abrasion might be caused in the web, because at a transfer suction roll the felts may have different speeds or tensions.

15 By means of an extended nip in itself, a higher dry solids content can be achieved than by means of a roll nip, because of the longer nip and the higher linear load. If the arrangement in accordance with the present invention is applied in the first nip, with a high speed or with a high basis weight, the runnability of the nip is better, as
20 compared with a roll nip.

It is a further advantage of the invention that, since, in a two-felt nip arranged in accordance with the present invention, the web is separated directly after the nip zone from the other felt, a possible difference in speed between said felts has no
25 detrimental effect on the web.

When an arrangement in accordance with the invention is employed in connection with an extended-nip zone, in particular when the extended nip is the last nip in the press, a sufficiently long time of dwell is obtained in the last nip while, nevertheless,
30 employing a sufficiently low peak compression pressure, in which case both a good and reliable transfer of the web, owing to the suction roll applied in the extended nip, and a sufficiently high dry solids content of the web are achieved, which dry

solids content is realized partly because an extended nip in itself has a good dewatering capacity, which is increased further by the suction roll also used as a backup roll in the extended nip, at the same time as rewetting is avoided.

- 5 The press section in accordance with the invention is particularly well suitable for the manufacture of all printing and writing paper grades, whose basis weight is, as a rule, lower than 100 g/m^2 . For the manufacture of printing and writing papers, such a preferred embodiment of the invention is particularly well suited in which two successive extended nips are used, both of which are two-felt nips, in which case a
- 10 particularly symmetric dewatering and, thereby, symmetry in the z-direction, which is required from printing papers, are achieved.

- In the present invention, when a press suction roll is used in an extended nip as the backup roll of the hose roll, owing to the high nip loads it is preferable to use a
- 15 sufficiently large suction roll diameter $D \approx 800 \dots 2000 \text{ mm}$ and a thickness of the mantle of the suction roll higher than normal, $s \approx 50 \dots 120 \text{ mm}$. As a press suction roll, in the present invention, it is also possible to use a variable-crown roll or an adjustable-crown roll, such as the applicant's roll with the trade mark **SymZ™Roll**.

- 20 Differing from the solutions of press suction rolls that are used most commonly, in the present invention the suction zone of the press suction roll is extended substantially to the width of the extended-nip zone only, in which case the width of the suction sector on the press suction roll is, as a rule, in the range $\sim 8^\circ \dots 16^\circ$, preferably in the range $\sim 10^\circ \dots 14^\circ$. By means of this arrangement, a sufficiently
- 25 sharp and efficient suction effect is obtained together with economies of suction energy, but it is, nevertheless, ensured that the web follows exactly the felt that is supposed to carry the web further after the nip zone.

- In a preferred embodiment of the invention, through the press section, a fully closed
- 30 draw is accomplished from the forming wire to the drying wire. In the present invention, an exception from this closed draw may be constituted by a short open

draw, which may be used in the invention, from the smooth-faced centre roll of the press section to the paper guide roll and further.

5 In the following, the invention will be described in detail with reference to a number of different exemplifying embodiments and variations of the invention illustrated in the figures in the accompanying drawing, the invention being, however, by no means strictly confined to the details of said embodiments or variations.

10 Figure 1 is a schematic illustration of the preferred embodiment of the invention, in which two successive extended-nip zones arranged in accordance with the invention and a fully closed draw of the web from the forming wire to the drying wire are employed.

15 Figures 2A, 2B, 2C, 2D, 2E, 2F, 2G, and 2H illustrate different variations of arrangements of the first press nip in a press section in accordance with the invention.

Figures 3A, 3B, 3C, 3D, 3E, and 3F are illustrations corresponding to Figs. 2A...2H of arrangements of the second and the last nip in a press section in accordance with the invention and of the draw of the web to the dryer section.

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Figures 4A, 4B, 4C, 4D, 4E, and 4F illustrate alternative arrangements of the first closed group of nips in a press section in accordance with the invention.

25 Figures 5A, 5B, 5C, and 5D illustrate the last separate extended nips employed in connection with the nip arrangements illustrated in Figs. 4A...4F.

Figures 6A and 6B illustrate two different nip arrangements at which the first press suction roll, at the same time, forms the pick-up point with the forming wire.

30 Figures 7A and 7B illustrate alternative modes of fitting of a last separate nip for use in connection with Figs. 6A and 6B.

Figures 8A and 8B illustrate such arrangements of the first nip in a press section in accordance with the invention in which, after a closed assembly of press rolls, the web is passed from the last press roll further by means of a particular transfer belt.

- 5 Figures 9A and 9B illustrate separate last nips in a press section for use in connection with Figs. 8A and 8B.

- 10 Figures 10A and 10B illustrate a press section in which the first press suction roll in the press forms the pick-up point and in which the web is passed further from the second press roll by means of a particular transfer belt.

Figures 11A and 11B illustrate alternative modes of fitting of the last separate nip in a press section for use in connection with Figs. 10A and 10B.

- 15 Fig. 1 illustrates the exemplifying embodiment of the invention that is, according to current knowledge, the most advantageous one, in particular in paper machines that produce printing and writing papers. The paper web W is separated from the forming wire 10 at the pick-up point P and transferred onto the suction zone 35a of the pick-up roll 35 onto the first upper felt 31, which is guided by its guide rolls 33.
- 20 The upper felt 31 carries the web W into the first extended nip NP1, which is provided with two felts and in which the lower felt is the lower felt 41 guided by the guide rolls 43, which carries the web W further after the extended-nip zone NP1. The web W is carried on the top face of the lower felt 41 as a straight run over the blow suction box 44 onto the second upper felt 32, onto which it is transferred on
- 25 the suction zone 36a of the transfer suction roll 36. After this the web W is carried on the lower face of the second upper felt 32 over the blow suction boxes 34 into the second extended nip NP2, after which the web W follows the second lower felt 42, which is guided by its guide rolls 43. On the downwards inclined straight run of the lower felt 42 the web W is passed from the second extended nip NP2 to the transfer
- 30 point S, at which the web W is transferred with the aid of the suction zone 50a of the transfer suction roll 50 onto the drying wire 51, which runs over blow suction boxes 52 onto the first drying cylinder 53 in the dryer section and from said cylinder

further in a known way. The function of the blow suction boxes 34 and 44 placed between the extended-nip zones NP1 and NP2 is to keep the web W in contact with the felt 41,32.

5 According to the present invention, the extended nips NP1 and NP2 have been formed between an upper shoe roll or hose roll 11 and 12 and a lower press suction roll 21,22 provided with a suction zone 23. The construction of the upper hose rolls 11,12 of the extended nips NP1 and NP2 is in itself known and comprises a flexible hose mantle 14, in whose interior there is a press shoe 13 which can be loaded by
10 means of a hydraulic pressure medium and by whose means the necessary compression pressure can be applied to the web W running between the felts 31,41;32,42 so that water is transferred in both nips NP1,NP2 into both felts substantially symmetrically so that a web sufficiently symmetric in the z-direction is obtained, which web has two identical faces. Such a paper is particularly suitable for writing or printing
15 paper. By means of the vacuum present in the suction zones 23 of the press suction rolls 21,22, it is secured that, after the two nips NP1,NP2, the web W follows the lower felt 41,42, in which case the lower felt 41,42 can be separated from the upper felt 31,32 directly after the nip zone, whereby rewetting of the web is substantially prevented. The extent of the suction zones 23 of the press suction rolls 21,22 is, as
20 a rule, just about $8^{\circ} \dots 16^{\circ}$, preferably $\sim 10^{\circ} \dots 14^{\circ}$, and extends over the area of the extended-nip zone or zones or just slightly beyond said area. Since, in the present invention, the press suction roll 21 and/or 22 is/are used in an extended-nip zone, said roll 21/22 must be measured more robust than a normal suction roll in order to endure the high linear loads in the extended nip. For this purpose, the diameter of
25 the press suction roll 21/22 is, as a rule, chosen in the range $D \approx 800 \dots 2000$ mm. The thickness of the perforated mantle of the press suction roll 21/22 and the perforations in said mantle are also dimensioned in view of high nip loads. For this purpose, the thickness s of the mantle of the suction roll 21/22 is, as a rule, chosen in the range $s \approx 50 \dots 120$ mm. The proportion of the open area in the mantle of the
30 suction roll 21/22, i.e. the percentage of holes R, is, as a rule, chosen in the range $R \approx 10 \dots 40$ %. The strength of the mantle of the suction roll 21/22 can also be increased by means of choice of its material. The level of vacuum P effective in the

suction zone 23 of the press suction roll 21/22 is, as a rule, chosen in the range $p \approx 30 \dots 70$ kPa, depending on the application.

5 Figs. 2A...2H illustrate different variations of embodiments of the first press nip in accordance with the invention. Similarly, Figs. 3A...3F illustrate different variations of carrying out the second nip in accordance with the invention and the last nip in the press section. The first press nips shown in Figs. 2A, 2B, 2C, and 2D are suitable for use in particular in connection with the last nip in any one of the press sections shown in Figs. 3A and 3B. Thus, the press sections can be carried into
10 effect favourably as the combinations 2A + 3A, 2A + 3B, 2B + 3A, 2B + 3B, 2C + 3A, 2C + 3B, 2D + 3A, 2D + 3B. Similarly, combinations of Figs. 2E + 3C, 2E + 3D, 2F + 3C, 2F + 3D, 2G + 3E, 2G + 3F, 2H + 3E, 2H + 3F are particularly usable.

15 In Fig. 2A, the first two-felt 31,41 nip is a roll nip N1, which is formed between two, preferably water-receiving hollow-faced press rolls 61 and 71. As is shown in Fig. 2B, the first nip N1 is a roll nip which is formed between an upper, preferably hollow-faced press roll 61 and a lower press suction roll 21, which is provided with a suction zone 23. In Fig. 2C, the first nip is an extended nip NP1, which is formed
20 between an upper hose roll 11 and a lower press suction roll 21 provided with a suction zone 23. In Fig. 2D, the first nip is an extended nip NP1, which is formed between an upper hose roll 11 and a lower smooth-faced or hollow-faced 72 press roll 71, which is not a suction roll, but which, if necessary, can be a variable-crown roll, such as a roll marketed by the applicant with the trade mark SymZL™ Roll.

25 The second and the last nip in the press, in accordance with Fig. 3A, is formed between an upper press suction roll 22 and a lower hose roll 12. In the last extended nip NP2 in the press section as shown in Fig. 3B, the hose roll 12 and the press suction roll 22 are placed in an inverse order, as compared with Fig. 3A. The roll nips N1, the extended nips NP1 and the second extended nips NP2 shown in Figs.
30 2A...2D and 3A and 3B are, all of them, two-felt 31,41;32,42 nips. As is shown in Fig. 3A, the web is passed on the upper felt 32 placed at the side of the press suction roll 22 as a closed draw onto the drying wire 51 of the dryer section, onto

which wire the web is transferred while secured by the vacuum present in the suction zone 50a of the transfer suction roll 50. Similarly, in Fig. 3B, the web W is passed after the last nip NP2 on the top face of the lower felt 42 placed at the side of the press suction roll 22 onto the drying wire 51.

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In Fig. 2E, the first nip NP1 is an extended nip, in which the lower roll is a hose roll 11 and the upper roll a press suction roll 21, owing to whose suction zone 23 the web W follows the upper felt 31, from which the web W is separated onto the suction zone 45a of the transfer suction roll 45 and is transferred onto the lower felt 42 passing into the second nip. In Fig. 2F, the first nip is a roll nip N1, and in it the lower roll is a press roll 71, whose mantle is smooth-faced or hollow-faced, and the upper roll 21 is a press suction roll, owing to whose suction zone 23 the web W follows the upper felt 31, from which it is transferred onto the suction zone 45a of the transfer suction roll 45 onto the lower fabric 42 that passes into the second nip.

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The last nip in the press section, shown in Figs. 3C and 3D, is an extended nip NP2, which is formed between a hose roll 12 and a press suction roll 22. In Fig. 3C, the web W follows the upper felt 32 owing to the suction zone 23 of the press suction roll 22, on which felt 32 the web is transferred onto the drying wire 51, and, similarly, in Fig. 3D, the web follows the lower felt 42.

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In Fig. 2G, the first nip NP1 is an extended nip, in which the upper roll is a hose roll 11 and the lower roll a press roll 71, which is smooth-faced 72. In stead of a lower felt, the lower fabric in the first extended nip NP1 is a smooth-faced transfer belt 41B, which does substantially not receive water and which, thus, does not rewet the web W. After the nip zone NP1 the web W follows the smooth outer face of the transfer belt 41B, from which it is transferred with the aid of the suction zone 36a of the transfer suction roll 36 onto the upper fabric of the second nip N2. As is shown in Fig. 2H, the upper fabric in the first extended nip NP1 is a smooth transfer belt 31B. The upper roll in the nip NP1 is a hose roll 11, and the lower roll 71 is a hollow-faced 72 press roll. After the nip NP1, the web follows the smooth face of the transfer belt 31B, from which it is transferred onto the lower felt 42 of the second nip. As is shown in Fig. 3E, the second and the last nip in the press

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section, which nip is an extended nip NP2, is formed by an upper press suction roll 22 and by a lower hose roll 12, and after the nip NP2 the web follows the upper fabric 32, from which it is transferred as a closed draw onto the drying wire 51. In Fig. 3F, as compared with Fig. 3E, the hose roll 12 and the press suction roll 22 have inverse positions, so that, after the nip NP2, the web W follows the lower felt 42.

Figs. 4A and 4B show a closed group of press rolls as the initial part of the press section. In Fig. 4A, there are three successive roll nips N1, N2 and N3, and what is concerned is the applicant's SymPress II™ press section. The first nip N1 is a two-felt nip. The first upper fabric 31a is both a pick-up fabric and a press fabric in the first and the second roll nip N1 and N2. Also, the lower felt 41a runs through the first nip N1. The first nip N1 is formed between a hollow-faced press roll 71a and an upper press suction roll 73. After the first nip N1, the web W follows the upper felt 31a by the effect of the suction zone 73a of the roll 73 and is transferred into the second roll nip N2, after which the web W follows the smooth face 74' of the centre roll 74. The third roll nip N3 is formed between the centre roll 74 and a press roll 75. Through the third roll nip N3, the press felt 76 runs. After the third roll nip N3 the web W follows the smooth face 74' of the centre roll 74, from which it is separated as a short free draw WP onto the paper guide roll 77 and is transferred onto the lower fabric 42 of the following nip. The press section shown in Fig. 4B differs from that shown in Fig. 4A in the respect that the third nip is an extended nip NP10, which is the first extended nip in the press section. The nip arrangement shown in Fig. 4C differs from that shown in Fig. 4A in the respect only that the first lower press roll 71a and the lower felt 41a are missing, so that the first and the second nip N1 and N2 are formed in connection with the centre roll 74.

Fig. 5A shows the separate last extended nip NP21 of the press section, in which nip the upper roll is a press suction roll 22 and the lower roll a hose roll 12, in which connection the web W follows the upper felt 32, on which it is transferred onto the drying wire 51. In Fig. 5B, the last nip in the press section is an extended nip NP21, in which the hose roll 12 and the press suction roll 22 are in an inverse order in

relation to one another, as compared with Fig. 5A, in which connection the web W follows the lower felt 42 after the nip NP21.

As is shown in Fig. 4D, the first group of press rolls is the applicant's so-called
5 **SymPress I™** press section, in which there are two successive roll nips N1 and N2, after which the web W is transferred from the smooth face 74' of the centre roll 74 as a short free draw WP on the paper guide roll 77 onto the lower felt 42 of the following nip. Fig. 4E shows a press section marketed by the applicant with the trade mark **SymPress O™**, in which the first roll nip N1 is formed between an upper
10 press suction roll 73' and a lower press roll 71a. From the first nip N1 the web is transferred over the suction zone 73a of the roll 73' as a substantially vertical draw into the second roll nip N20, which is formed between the press roll 78 and the centre roll 74. In connection with the centre roll 74, further, the third press nip N30 in the press section is formed.

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Fig. 4F, shows such an initial end of a press section as comprises the first extended nip NP10, which is in the position of the first roll nip N1 as shown in Figs. 4A, 4B, 4D, and 4E. After the extended nip NP10 the web W follows the suction zone of the press suction roll 73 into the second nip N21, which is formed in connection with
20 the smooth-faced centre roll 74. Further, in connection with the centre roll 74, there is the second extended nip NP11 of the press section, which nip is formed between the centre roll 74 and the upper hose roll 12. Through the second extended nip NP11 the press felt 76 runs. Fig. 5C shows the separate last nip of the press section, which nip is the first extended nip NP10 of the press section if an arrangement of nips as shown in Fig. 4D or 4E is employed, or the third extended nip NP30 of the press
25 section if an arrangement of nips as shown in Fig. 4F is employed, in which arrangement of nips there are two extended nips NP10 and NP11. In Fig. 5C, the upper roll of the extended nip NP10 (NP30) is a press suction roll, and the lower roll is a hose roll 12. In Fig. 5D, said rolls 12 and 22 are placed in an inverse order
30 in relation to one another.

In Fig. 6A, as the first arrangement of nips in the press section, a what is called Combi press is shown, in which the first roll 73b in the press section forms the first press nip N1 or a transfer nip with the centre roll 74. In connection with the centre roll 74, the second roll nip N2 in the press section is formed in connection with the press roll 73. The press felt 76 runs through the second nip N2, from which felt the web W is separated and passed onto the smooth face of the centre roll 74 and further as a short free draw WP over the paper guide roll 77 onto the lower fabric 42 of the following nip. The arrangement of nips illustrated in Fig. 6B differs from that shown in Fig. 6A in the respect that a smooth-faced transfer belt 80 substantially not receiving water has been arranged to run around the centre roll 74a, the web W being passed on the face of said belt 80, after the second nip N2, onto the upper felt 32 of the following nip. The initial part of the press section shown in Fig. 6A is as such suitable for use together with the latter half of the press section as shown both in Fig. 7A and in Fig. 7B. On the contrary, when an initial part of the press as shown in Fig. 6B is used, the running of the fabrics 32 and 42 must be changed so as to comply with Fig. 6B.

Fig. 7A shows an extended nip NP10 as the last separate nip in the press section, in which nip NP10 the upper roll is a press suction roll 22 and the lower roll a hose roll 12. In Fig. 7B, said rolls 12,22 are in an inverse order, compared with Fig. 7A.

Fig. 8A illustrates a press section mainly similar to Fig. 6B described above, in which there are two roll nips N1 and N2 and in which, around the centre roll 74a, a smooth-faced transfer belt 80 not receiving water has been arranged, by whose means the web W is passed as a closed draw onto the upper felt 32 of the following nip. The press section illustrated in Fig. 8B differs from that shown in Fig. 8A in the respect that the first nip is an extended nip NP10, whose lower roll is a hose roll 12. In the other respects, the construction is similar to that shown in Fig. 8A. In Fig. 9A, an extended nip NP20 is shown as the last separate nip in the press section, in which nip the upper roll is a press suction roll 22 and the lower roll is a hose roll 12. In Fig. 9B, the press rolls 12,22 are fitted in an inverse order, compared with Fig. 9A.

Fig. 10A shows such a what is called Combi press in which the suction roll 73b forms a pick-up point P with the forming wire 10. A felt 31b runs over the suction zone 73a of the press suction roll 73b, the web being carried on support of said felt 31b onto the second press roll 74, which forms the first roll nip N1 with the press suction roll 73b. Around the second press roll 74, a transfer belt 80 has been arranged running, on whose support the web W is transferred as a closed draw onto the upper felt 32 of the following press nip. The press section shown in Fig. 10B differs from that shown in Fig. 10A in the respect that the first nip in the press section is an extended nip NP1, which is formed between a press suction roll 73b and a hose roll 11. Around the hose roll 11, a smooth, impermeable transfer belt 80 has been arranged, on which the web W is carried as a closed draw onto the upper fabric 32 of the following nip, onto which fabric the web is transferred as a transfer by means of a suction roll.

As the last nip in the press section, Figs. 11A and 11B show an extended nip, which is the first extended nip NP10 of the press section if a first nip N1 as shown in Fig. 10A is employed, or the second extended nip NP20 of the press section if an extended nip NP1 as shown in Fig. 10B is employed. In Figs. 11A and 11B the press suction roll 22 and the hose roll 12 are placed in an inverse order in relation to one another.

As comes out from the accompanying illustrations, in a number of embodiments of the invention, it is also an essential feature that the run of the web through the whole press section is highly linear so that there are no major curves in the run of the web, which curves might subject the web to such high dynamic forces that the web is separated from the supporting face, such as a press felt or a transfer belt. For example, in Fig. 1, the largest angle α of change in direction of the web W is in connection with the second extended nip NP2, $\alpha \approx 30^\circ \dots 40^\circ$. As a rule, said maximal angle of change in direction is in a range $\alpha < 45^\circ$, preferably $\alpha \lesssim 30^\circ$. In the areas of the nips NP1 and NP2, the angle of change in direction corresponds to the width of the suction sector 23 of the press suction roll 21, 22, which sector 23

is, as was stated above, relatively little and extends just substantially over the extended-nip zone NP1/NP2 or slightly beyond said zone.

In the following, the patent claims will be given, and various details of the invention
5 can show variation within the scope of the inventive idea defined in said claims and differ from the details disclosed above for the sake of example only.

Claims

1. A press section in a paper machine, which press section comprises at least two separate press nips (NP1,NP2;N1,N2,N10,N20,N30,NP10,NP11,NP20,NP21, NP30), through which the paper web (W) to be pressed is passed as a substantially closed draw and in which press section there is at least one press nip provided with two press felts (31,41;32,42) that receive water, through which press nip the paper web (W) runs between said press felts (31,41;32,42) and after which last-mentioned nip the paper web (W) is separated from one of the press felts (31/41;32/42) and transferred on support of the other press felt (41/31;42/32) substantially as a closed draw further, characterized in that the last nip in the press section is an extended-nip zone (NP2;NP10;NP20,NP21,NP30), in which one roll is a shoe roll (12) provided with a hose mantle (14) and with a press shoe arrangement (13) and the other roll is a press suction roll (22) provided with a suction zone (23), that the paper web (W) is passed through said last extended-nip zone (NP2;NP10;NP20, NP21,NP30) between two press fabrics (32,42), that directly after said last extended-nip zone (NP2;NP10;NP20,NP21,NP30) the paper web (W) is separated from one of the press fabrics (32/42) and transferred, with the aid of the vacuum present in the suction zone (23) of said press suction roll (22), to follow the press fabric (42/32) placed at the side of said press suction roll (22) without substantial rewetting, and that the paper web (W) is passed on the latter press fabric (32,42) as a closed draw onto a drying wire (51) or equivalent of the dryer section following after the press section, onto which drying wire or equivalent the web (W) is transferred as a suction roll (50,50a) transfer or by means of an equivalent arrangement.
2. A press section in a paper machine, which press section comprises at least two separate press nips (NP1,NP2), through which the paper web (W) to be pressed is passed as a substantially closed draw and in which press section there is at least one press nip provided with two press felts (31,41;32,42) that receive water, through which press nip the paper web (W) runs between said press felts (31,41;32,42) and after which last-mentioned nip the paper web (W) is separated from one of the press felts (41/31;42/32) and transferred on support of the other press felt (31/41;32/42)

substantially as a closed draw further, **characterized** in that two fabrics (31,41) or equivalent are passed through the first extended-nip zone (NP1) in the press section, of which fabrics or equivalent at least one is a press felt (31/41) that receives water, that said extended-nip zone (NP1) is formed by a shoe roll (11) provided with a flexible hose mantle (14) and by a press suction roll (21) operating opposite to said shoe roll and provided with a suction zone (23) which is fitted in the area of said extended-nip zone (NP1), that said press felt (31/41) that receives water has been fitted around, and in connection with, said press suction roll (21) so that the paper web (W) is separated from the other press fabric (41/31) and follows said press felt (31/41) that receives water with the aid of the vacuum in the suction zone (23) in the press suction roll (21) without substantial rewetting, and that on said press felt (31/41) the web (W) is passed further as a closed draw onto a press fabric (32/42) of the following press nip (NP2) in the press section.

3. A press section as claimed in claims 1 and 2, **characterized** in that in the press section the first press nip is an extended-nip zone (NP1) as referred to in claim 2, and the second press nip is an extended-nip zone (NP2) as referred to in claim 1, and that the paper web (W) has a closed draw between said extended-nip zones (NP1, NP2) and from the forming wire (10) into the first extended-nip zone (NP1) and from the last extended-nip zone (NP2) into the dryer section (Figs. 1, 2C + 3A, 2C + 3B, 2D + 3A, 2D + 3B, 2G + 3E, 2G + 3F, 2H + 3E, 2H + 3F, 2I + 3C, 2E + 3D, 2F + 3C, 2F + 3D).

4. A press section as claimed in any of the claims 1 to 3, **characterized** in that in the press section the first upper felt is a pick-up felt (31), which carries the paper web (W) into the first press nip, which is most appropriately an extended nip (NP1), in which nip the upper roll is a shoe roll (11) provided with a hose mantle (14), and the lower roll is a press suction roll (21), and that a first lower felt (41) has been arranged running around said lower press suction roll (21), which felt (41) carries the paper web (W), substantially without rewetting, on its top face onto the upper felt (32) of the second extended-nip zone (NP2), onto which felt the web is transferred as a suction roll (36, 36a) transfer, and that a second lower fabric (42) has

been arranged to run through the second extended-nip zone (NP2), which fabric (42) carries the paper web (W), substantially without rewetting, on its top face as a closed draw onto the drying wire (51) of the dryer section, onto which wire the paper web (W) is transferred as a suction roll (50,50a) transfer (Fig. 1).

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5. A press section as claimed in any of the claims 1 to 4, **characterized** in that the suction zone (23) of the press suction roll (21,22) is relatively narrow and extends substantially just over the area of the extended-nip zone (NP1,NP2), and that the width of the sector of said suction zone (23) in the machine direction is $\sim 8^\circ \dots 16^\circ$,
10 preferably $\sim 10^\circ \dots 14^\circ$.

6. A press section as claimed in any of the claims 1 to 5, **characterized** in that, in the press section, as the first press nips, there is/are one or several roll nips (N1, N2,N10,N20,N30) and after that, as the last nip, an extended nip (NP2;NP20,
15 NP21,NP30).

7. A press section as claimed in any of the claims 1 to 6, **characterized** in that, in the press section, the first nip is a roll nip (N1), which is followed by one or two roll nips (N2;N2,N3) and after that by one or several extended nips (NP2,NP10,
20 NP21,NP30).

8. A press section as claimed in claim 7, **characterized** in that the first nips in the press section are formed in connection with a compact combination of rolls, in which there is a centre roll (74), from whose smooth face (74') the web (W) is separated
25 as a short free draw (WP) and transferred by means of a paper guide roll (77) or equivalent onto one of the press fabrics (42) of the last separate nip in the press section, which nip is preferably an extended nip (NP10;NP30).

9. A press section as claimed in any of the claims 1 to 6, **characterized** in that the
30 first nip in the press section is an extended nip (NP10), through which a lower press felt (41a) and an upper press felt (31a) run, which upper press felt also operates as a pick-up felt at the same time, that said first press nip (NP10) is formed between a

lower shoe roll (11) and an upper press suction roll (73), that said upper felt (31a) operates as a press fabric also in the second nip in the press section, which nip is a roll nip (N21) in which one of the rolls is the smooth-faced centre roll (74), in connection with which roll (74), as the third nip in the press section, there is either
5 a roll nip (N30) or a second extended nip (NP11) (Fig. 4F).

10. A press section as claimed in any of the claims 1 to 9, **characterized** in that, through the roll nip (N1) or roll nips (N1,N2) or through an extended nip (NP1) in the press section, a transfer belt (80;31B;41B) has been passed which does substan-
10 tially not receive water and on whose support the web (W) is transferred after the last-mentioned nip as a closed draw onto a press fabric (32/42) of the following nip.

AMENDED CLAIMS

[received by the International Bureau on 8 October 1999 (08.10.99);
original claims 1, 2, 3 and 7 amended;
remaining claims unchanged (4 pages)]

1. A press section in a paper machine, which press section comprises at least two separate press nips (NP1,NP2;N1,N2,N10,N20,N30,NP10,NP11,NP20,NP21,
5 NP30), through which the paper web (W) to be pressed is passed as a substantially closed draw and in which press section there is at least one press nip provided with two press felts (31,41;32,42) that receive water, through which press nip the paper web (W) runs between said press felts (31,41;32,42) and after which last-mentioned nip the paper web (W) is separated from one of the press felts (31/41;32/42) and
10 transferred on support of the other press felt (41/31;42/32) substantially as a closed draw further, **characterized** in that the last nip in the press section is an extended-nip zone (NP2;NP10;NP20,NP21,NP30), in which one roll is a shoe roll (12) provided with a hose mantle (14) and with a press shoe arrangement (13) and the other roll is a press suction roll (22) provided with a suction zone (23), that the
15 paper web (W) is passed through said last extended-nip zone (NP2;NP10;NP20, NP21,NP30) between two water receiving press felts (32,42), that directly after said last extended-nip zone (NP2;NP10;NP20,NP21,NP30) the paper web (W) is separated from one of the press felts (32/42) and transferred, with the aid of the vacuum present in the suction zone (23) of said press suction roll (22), to follow the
20 press felt (42/32) placed at the side of said press suction roll (22) without substantial rewetting, and that the paper web (W) is passed on the latter press felt (32;42) as a closed draw onto a drying wire (51) or equivalent of the dryer section following after the press section, onto which drying wire or equivalent the web (W) is transferred as a suction roll (50,50a) transfer or by means of an equivalent arrangement.
- 25
2. A press section as claimed in claim 1, **characterized** in that the first nip in the press section is an extended-nip zone (NP1,NP10), in which one roll is a shoe roll (11) provided with a hose mantle (14) and with a press shoe arrangement (13) and the other roll is a press suction roll (21) provided with a suction zone (23), that the
30 paper web (W) is passed through said first extended-nip zone (NP1,NP10) between two press fabrics (31,41; 31a,41a), of which fabrics at least one is a water receiving press felt (31/41), that said water receiving press felt (31/41) has been fitted around,

and in connection with, said press suction roll (21), that the paper web (W) is separated from the press fabric (41/31) placed at the side of the shoe roll (11) and transferred, with the aid of the vacuum present in the suction zone (23) of said press suction roll (21) to follow said water receiving press felt (31/41) without substantial rewetting, and that the paper web (W) is passed on said water receiving press felt (31/41) further as a closed draw onto a press fabric (32/42) of the following press nip (NP2) in the press section.

3. A press section as claimed in claims 1 and 2, characterized in that in the press section the first press nip is an extended-nip zone (NP1) as referred to in claim 2, and the second press nip is an extended-nip zone (NP2) as referred to in claim 1, and that the paper web (W) has a closed draw between said extended-nip zones (NP1, NP2) and from the forming wire (10) into the first extended-nip zone (NP1) and from the last extended-nip zone (NP2) into the dryer section (Figs. 1, 2C + 3A, 2C + 3B, 2E + 3A, 2E + 3B).

4. A press section as claimed in any of the claims 1 to 3, characterized in that in the press section the first upper felt is a pick-up felt (31), which carries the paper web (W) into the first press nip, which is most appropriately an extended nip (NP1), in which nip the upper roll is a shoe roll (11) provided with a hose mantle (14), and the lower roll is a press suction roll (21), and that a first lower felt (41) has been arranged running around said lower press suction roll (21), which felt (41) carries the paper web (W), substantially without rewetting, on its top face onto the upper felt (32) of the second extended-nip zone (NP2), onto which felt the web is transferred as a suction roll (36, 36a) transfer, and that a second lower fabric (42) has been arranged to run through the second extended-nip zone (NP2), which fabric (42) carries the paper web (W), substantially without rewetting, on its top face as a closed draw onto the drying wire (51) of the dryer section, onto which wire the paper web (W) is transferred as a suction roll (50, 50a) transfer (Fig. 1).

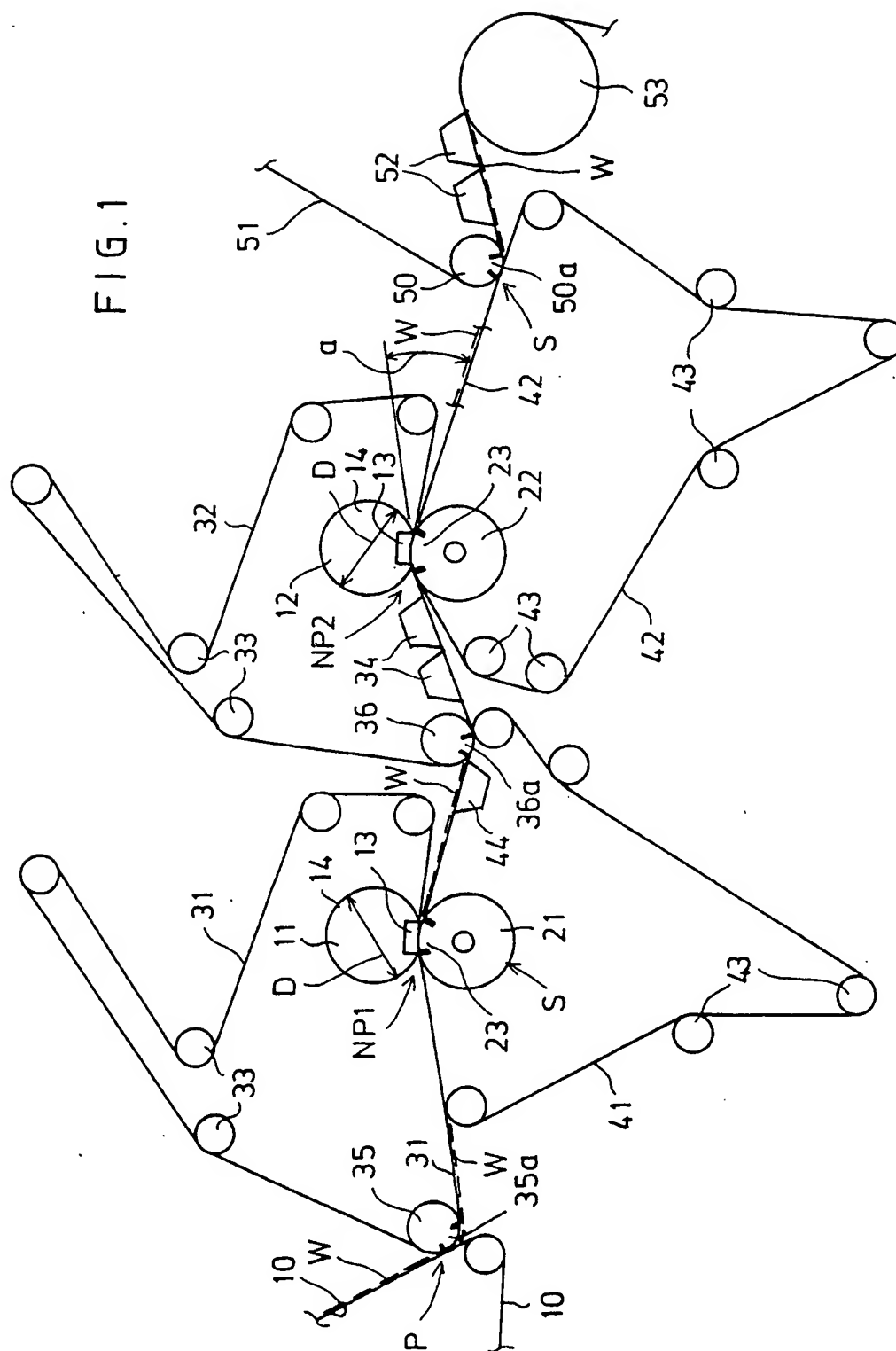
5. A press section as claimed in any of the claims 1 to 4, characterized in that the suction zone (23) of the press suction roll (21, 22) is relatively narrow and extends

substantially just over the area of the extended-nip zone (NP1,NP2), and that the width of the sector of said suction zone (23) in the machine direction is $\sim 8^\circ \dots 16^\circ$, preferably $\sim 10^\circ \dots 14^\circ$.

- 5 6. A press section as claimed in any of the claims 1 to 5, **characterized** in that, in the press section, as the first press nips, there is/are one or several roll nips (N1, N2,N10,N20,N30) and after that, as the last nip, an extended nip (NP2;NP20, NP21,NP30).
- 10 7. A press section as claimed in any of the claims 1 or 4 to 6, **characterized** in that, in the press section, the first nip is a roll nip (N1), which is followed by one or two roll nips (N2;N2,N3) and after that by one or several extended nips (NP2,NP10, NP21,NP30).
- 15 8. A press section as claimed in claim 7, **characterized** in that the first nips in the press section are formed in connection with a compact combination of rolls, in which there is a centre roll (74), from whose smooth face (74') the web (W) is separated as a short free draw (WP) and transferred by means of a paper guide roll (77) or equivalent onto one of the press fabrics (42) of the last separate nip in the press
- 20 section, which nip is preferably an extended nip (NP10;NP30).
- 25 9. A press section as claimed in any of the claims 1 to 6, **characterized** in that the first nip in the press section is an extended nip (NP10), through which a lower press felt (41a) and an upper press felt (31a) run, which upper press felt also operates as a pick-up felt at the same time, that said first press nip (NP10) is formed between a
- 30 lower shoe roll (11) and an upper press suction roll (73), that said upper felt (31a) operates as a press fabric also in the second nip in the press section, which nip is a roll nip (N21) in which one of the rolls is the smooth-faced centre roll (74), in connection with which roll (74), as the third nip in the press section, there is either a roll nip (N30) or a second extended nip (NP11) (Fig. 4F).

10. A press section as claimed in any of the claims 1 to 9, characterized in that, through the roll nip (N1) or roll nips (N1,N2) or through an extended nip (NP1) in the press section, a transfer belt (80;31B;41B) has been passed which does substantially not receive water and on whose support the web (W) is transferred after the
- 5 last-mentioned nip as a closed draw onto a press fabric (32/42) of the following nip.

FIG. 1



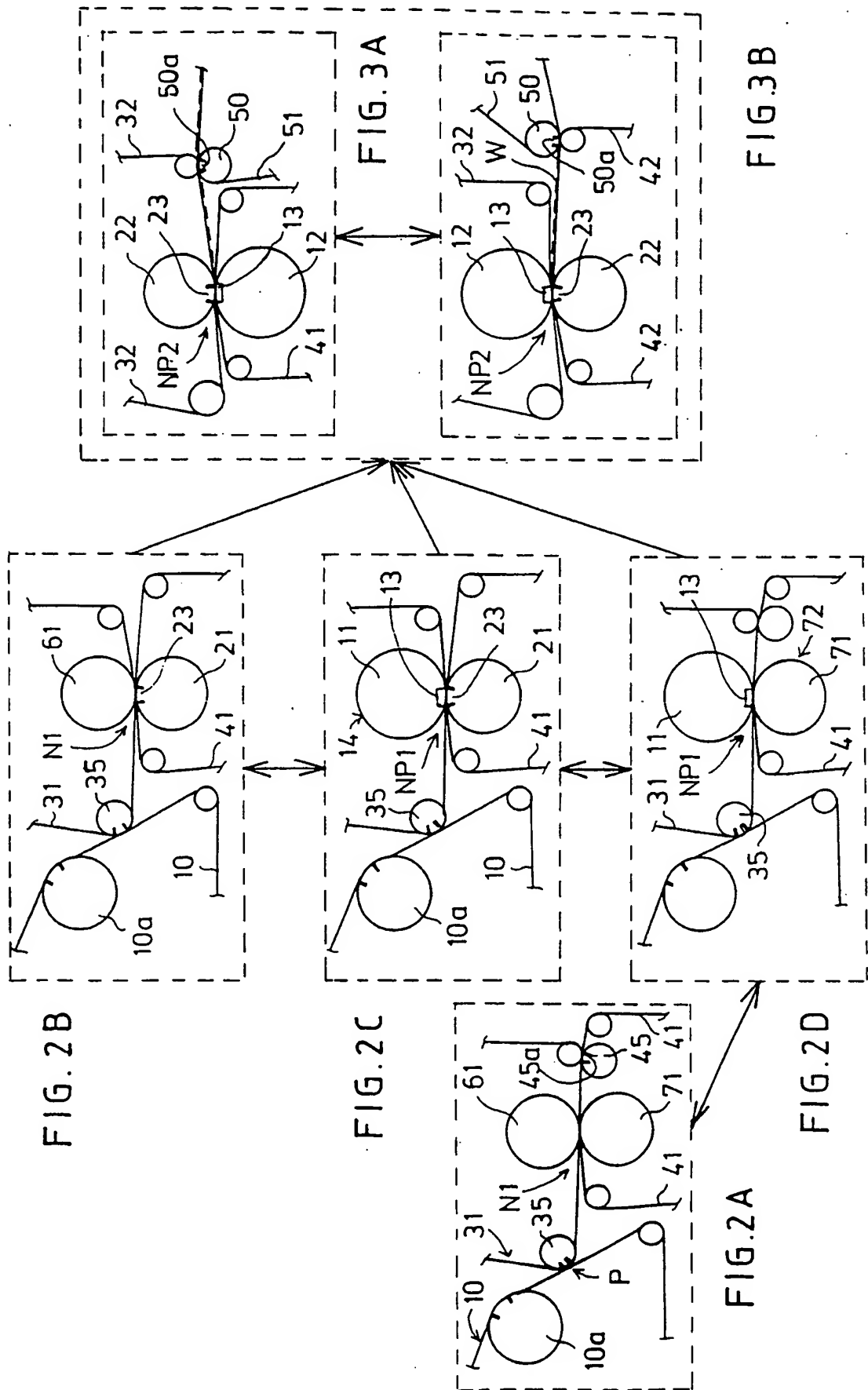


FIG. 3C

FIG. 3D

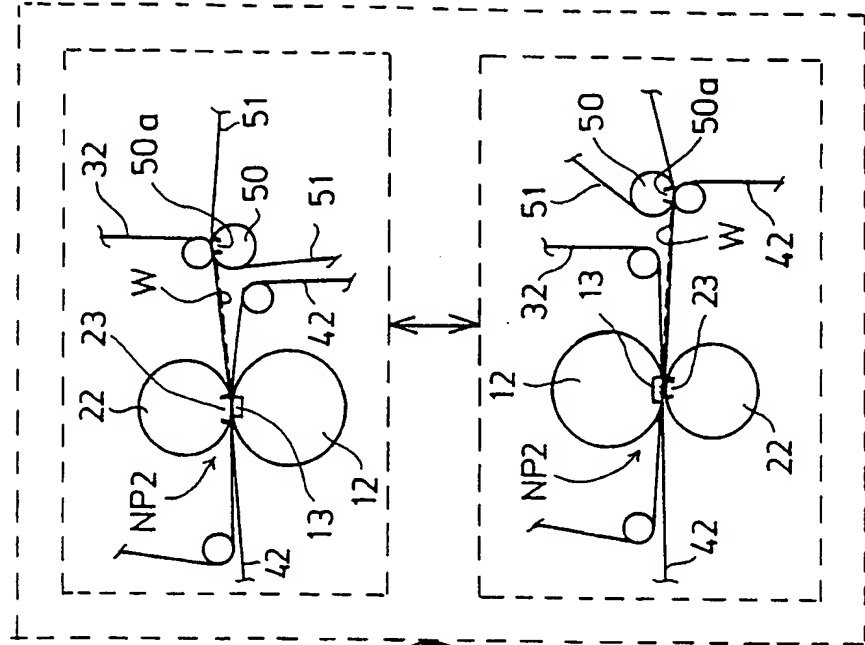


FIG. 2E

FIG. 2F

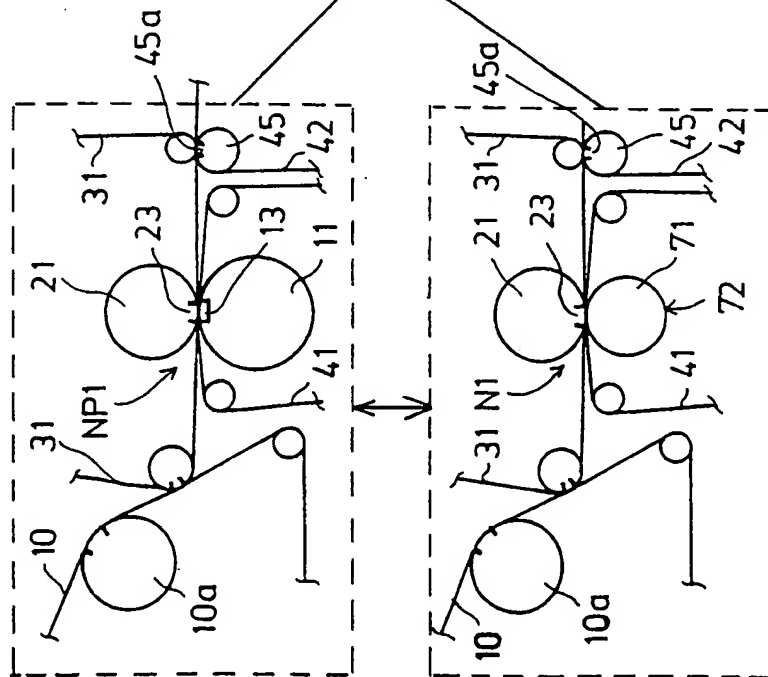


FIG.3E

FIG.3F

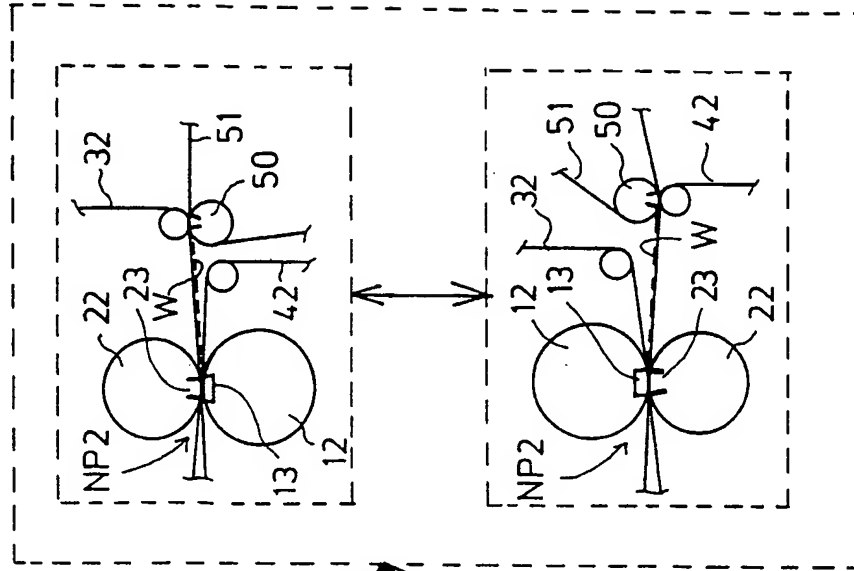


FIG.2G

FIG.2H

